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Study regarding the overall migration from plastic packaging materials used in food industry

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Abstract

The overall migration from plastic packaging used in food industry into the aqueous simulants (distilled water, 3% acetic acid and 95% ethanol) was determined. The results showed that for tested type of plastics (low density polyethylene) for overall migration into aqueous simulants were significantly lower than the upper limit (10 mg/dm^2) set by the Commission Regulation (EU) No 10/2011 of 14 January 2011 on plastic materials and articles intended to come into contact with food. Mathematical statistical models were elaborated.

Keywords: overall migration, plastic, food packaging, mathematical modeling.

1. Introduction

Packaging has become an indispensible element in the food manufacturing process, and different types of additives, such as antioxidants, stabilizers, lubricants, anti-static and anti-blocking agents, have also been developed to improve the performance of polymeric packaging materials. Recently the packaging has been found to represent a source of contamination itself through the migration of substances from the packaging into food [1].

Testing for compliance with the specific migration limits can be achieved in several ways. The food itself can be tested. The food contact material or article can be tested before it is used to ensure that it does not contain residues that can migrate at levels that could cause problems. Finally, uniquely for food contact materials, the food contact material or article can be tested for its suitability before use by employing food simulants that are intended to mimic the migration properties of different categories of foods. There are five simulants described in the legislation for plastics [2]: distilled water or water of equivalent quality, 3% acetic acid (w/v) in aqueous solution, 10% ethanol (v/v) in aqueous solution, rectified olive oil and 50% ethanol (v/v) in aqueous solution. These simulants mimic under worst case conditions aqueous foods, acidic foods, alcoholic foods and fatty foods [3].

The overall migration limit has been assigned to ensure that materials do not transfer large quantities of substances which, even if they are not unsafe, could bring about an unacceptable change in the composition of the food [3].

2. Materials and Methods

The objectives of this work were to determine the overall migration from a wide range of commercial plastic samples made from low density polyethylene, into the aqueous food simulants to determine the overall migration from commercial plastic packing materials used in food industry.

Test conditions for packaging material/food simulant contact and method of overall migration analysis

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were according to the standard, "EN 1186-9:2002 materials and articles in contact with foodstuffs, test methods for overall migration into aqueous food simulants by article filling". For the overall migration, reagents used in the study were distilled water (simulant A), Acetic acid 3 % (w/v) in aqueous solution (simulant B) and Ethanol 10 % (v/v) in aqueous solution (simulant C) [4]. The plastic material used in the study was low density polyethylene plastic cups. Twenty different plastics cups of different capacities were used. Procedure for the determination of the overall migration into aqueous based food simulants from plastics cup intended to come into contact with foodstuffs, were by filling (one side contact) the plastic cups with corresponding aqueous simulant to within 0,5 cm of the top of the cup. The cups were covered by glass so as to avoid evaporation of simulant during contact period to prevent evaporation and kept in a thermostatically controlled oven at 40 °C for ten days, respectively 2 hours at 70 °C. After exposure to the simulant the plastic cups were removed from the oven, emptied and the simulant was placed in a 250-ml preweighed Erlenmeyer flask and evaporated to dryness by means of a hot plate. The Erlenmeyer flask containing the residue of evaporation was kept in a thermostatically controlled oven at 105±1.0 °C for 1 h followed by 1 h in a desiccator and then weighed. An analytical balance capable of weighing to 0.1 mg was used. The mass of the non-volatile residue was determined and expressed as milligrams per square decimetre of surface area exposed to the simulant. Overall migration was calculated as the mean of three determinations on separate test specimens.

The overall migration was expressed as milligrams of residue per square decimetre of the surface of the sample which were intended to come into contact with foodstuffs, calculated for each test specimen using the following formula [4]:

$$M = \frac{m_a - m_b \times 1000}{S} \qquad (1)$$

where:

M is the overall migration into the stimulant, in milligrams per square decimetre of surface area of sample;

m_a is the mass of the residue from the test specimen after evaporation of the simulant which had filled the test specimen, in grams;

m_b is the mass of residue from the blank simulant equal to the volume which had filled the test specimen, in grams;

S is the surface area of the test specimen which was in contact with the simulant during the exposure, in square decimetres.

3. Results and Discussion

A plastics food contact material such as food packaging, kitchen utensils and food processing equipment needs to be compliant for the overall migration level. The laboratory testing capabilities should provide knowledge, expertise for assessing compliance of plastics food contact materials to the relevant EU regulation (EU) 10/2011).

The overall migration experiments were studied, with LDPE samples in contact with stimulant A,B and C, at 70°C and 40°C for approximately 2 hours and 10 days.

The results show that the overall migration values from all studied plastic materials into simulant A were between 4.06–5.06 mg/dm^2. The overall migration studies' using simulant A shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food simulant A - distilled water, after two hours contact at 70°C are shown in figure 1.

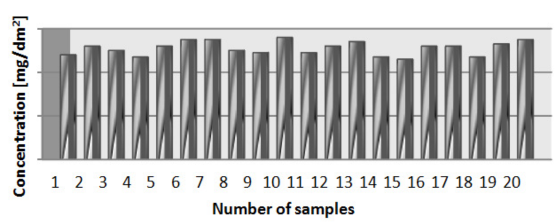

Figure 1. Overall migration in distilled water after two hours contact at 70°C

The results shows that the overall migration values from all studied plastic materials into simulant B were between 4.10–5.90 mg/dm^2. The overall migration studies using simulant B shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food simulant B after two hours contact at 70°C are shown in figure 2.

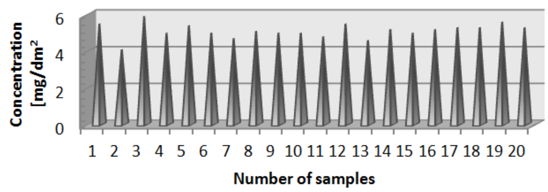

Figure 2. Overall migration in 3% aqueous acetic acid after two hours contact at 70°C

The results show that the overall migration values from all studied plastic materials into simulant C were between 4.20–5.80 mg/dm^2. The overall migration studies using simulant C shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food simulant C after two hours contact at 70°C are shown in figure 3.

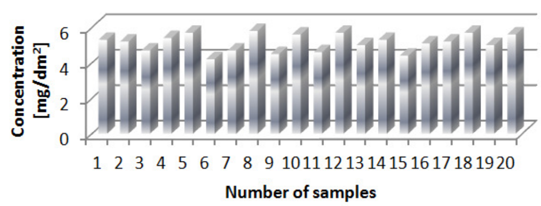

Figure 3. Overall migration in 10% ethanol for two hours contact at 70°C

The results shows that the overall migration values from all studied plastic materials into simulant A after ten days contact at 40± 0.5 °C, were between 4.20–5.80 mg/dm^2. The overall migration studies' using simulant A shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food simulant A after ten days contact at 40± 0.5 °C are shown in figure 4.

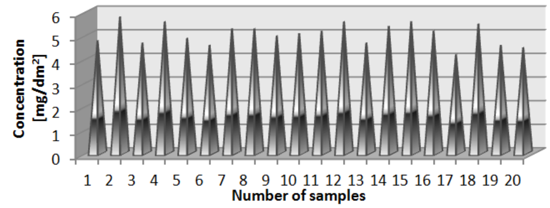

Figure 4. Overall migration in distilled water for ten days contact at 40± 0.5°C

The results shows that the overall migration values from all studied plastic materials into simulant B after ten days contact at 40± 0.5 °C, were between 4.20–5.70 mg/dm^2. The overall migration studies using simulant B shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food s simulant B after ten days contact at 40± 0.5 °C are shown in figure 5.

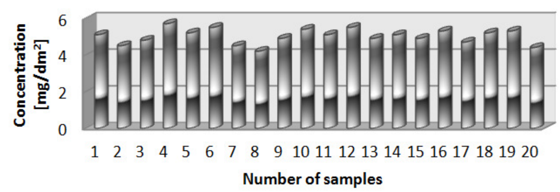

Figure 5. Overall migration in 3% aqueous acetic acid for ten days contact at 40± 0.5°C

The results show that the overall migration values from all studied plastic materials into simulant C were between 4.20–5.90 mg/dm^2. The overall migration studies using simulant C shows that the migration rate was very low, far below the allowed limit (10 mg/dm2) set by the EU regulation (EU) 10/2011).

Overall migration values from the plastic cups into aqueous food simulant C after ten days contact at 40± 0.5 °C are shown in figure 6.

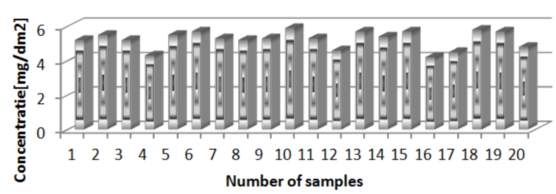

Figure 6. Mesurements for overall migration in 10% ethanol as food simulant ten days contact at 40± 0.5°C

4. Conclusion

The results show that the overall migration values from all studied plastic materials into aqueous simulants (distilled water, 3% acetic acid and 95% ethanol) were much lower than the upper limit for migration set by the EU (10 mg/dm^2) for two hour contact time at 70°C, respectively ten days contact at 40± 0.5 °C.

Compliance with Ethics Requirements

Authors declare that they respect the journal's ethics requirements. Authors declare that they have no conflict of interest and all procedures involving human and/or animal subjects (if exists) respect the specific regulations and standards.

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